

Questions on CPU Performance

Question-1

A compiler designer is trying to decide between two code sequences for a particular computer. The hardware designers have supplied the following facts:

Instruction Class	CPI
A	1
B	2
C	3

For a particular high-level language statement, the compiler writer is considering two code sequences that require the following instruction counts:

Code sequence	IC for instruction Class		
	A	B	C
C1	2	1	2
C2	4	1	1

Answer the following questions:

- Which code sequence executes the most instructions?
C1 executes 5 (2+1+2) instructions, C2 executes (4+1+1) 6 instructions - Ans is Code sequence C2 executes most instructions.
- Which will be faster?
since C2 requires lesser no.of clock cycles it will be faster
- What is the CPI for each sequence?
Ans: CPI for C1 = 2, CPI for C2 = 1.5

Question-2

Consider two different machines, with two different instruction sets, both of which have a clock rate of 200 MHz. The following measurements are recorded on the two machines running a given set of benchmark programs:

Instruction Type	Instruction Count (millions)	Cycles per Instruction
Machine A		
Arithmetic and logic	8	1
Load and store	4	3
Branch	2	4
Others	4	3
Machine B		
Arithmetic and logic	10	1
Load and store	8	2
Branch	2	4
Others	4	3

. Determine the effective CPI, MIPS rate, and execution time for each machine.

For Machine:A

CPI (Ma) = 2.22, MIPS = 90, Execution Time = 0.198 Sec

For Machine:B

CPI = 1.92 , MIPS = 104.3 MIPS, Execution Time = 0.23 sec

Question-3

A computer with a processor having clock speed of 500 MHz will take 3 clock cycles to execute ALU instructions, 2 clock cycles for branch instructions , 4 clock cycles for store word instructions and 5 clock cycles for load word instructions.

Also, consider a program that executes following instructions.

ALU instructions : 200 million

Branch instructions: 55 million

Store Word instructions: 25 million

Load Word instructions: 20 million

Find Total time taken by CPU for execution of above instructions assuming CPU is executing all instructions sequentially.

CPU Execution Time = 1.82 Sec

Questions on Amdahl's Law

Question-4

A programmer is given the job to write a program on a computer with processor having speedup factor 3.8 on 4 processors. He makes it 95% parallel and goes home dreaming of a big pay raise. Using Amdahl's law, and assuming the problem size is the same as the serial version, and ignoring communication costs, what is the speedup factor that the programmer will get?

Given $f = 0.95$, $k = 4$

$$S = \frac{1}{(1-f) + \frac{f}{k}}$$

Speed Up Factor $S = 3.478$

Question-5

A programmer has parallelized 99% of a program, but there is no value in increasing the problem size, i.e., the program will always be run with the same problem size regardless of the number of processors or cores used. What is the expected speedup on 20 processors?

Speed Up Factor $S = 16.95$

Questions on Memory

Question-6

An application specifies a requirement of 200GB to host a database and other files. It also specifies that the storage environment should support 5,000 IOPS during its peak processing cycle. The disks available for configuration provide 66GB of usable capacity, and the manufacturer specifies that they can support a maximum of 140 IOPS. The application is response time sensitive and disk utilization beyond 60 percent will not meet the response time requirements of the application. Compute number of disks that should be configured to meet the requirements of the application.

Number of Disks required = Max (size requirement, IOPS Requirement)

No. of disks to meet size requirement = $200\text{GB}/66\text{GB} = 3.03$ i.e. 4 disks

And

No. of disks to meet IOPS requirement = $5000 / (140 \times 0.6) = 60$ Disks

Number of Disks required = Max (4,60) = 60 disks

Question-7

Compute the capacity of the disk with the following parameters 256 bytes per sector, 600 sectors per track, 40,000 tracks per surface, 2 surfaces per platter and 7 platters per disk.

Capacity = 86.016 GB